

I *An Experiment made before the President and Fellows of the Royal Society, in which a surprizing change of Colour from a pale Transparent or Clear Liquor, to a very Blue Cernuleous one was exhibited, and that in an instant, by the admission of Air only : Apply'd to illustrate some changes of Colour, and other Effects on the Blood of Respiring Animals. By Fr. Slare, M. D. Fellow of R. S. and Censor of the Colledge of Physicians.*

IN order to the making of this Experiment, the Operator should furnish himself with a quantity of Filings of Copper fresh made, and place them in a Glass Vial, whose bottom is broad and even, and then pour on a Urinous Spirit, either of *Sal Armoniac*, or of Urine it self, not made with Quick-Lime : The Glass should not be fill'd up much above one half-way, and then must presently be so exactly stoppt that no Air be capable of intruding ; for if you err in a Circumstance the Experiment will not succeed. The Foundation of this Experiment is justly due to the Immortal Mr. *Boyle*, but our Aims are very differing in the Application, as well as in the manner of preparing and exhibiting the Experiment. He was searching after some hidden proprieties of the Air, and particularly apply'd it to the broken or lessen'd Spring of the Air, which this *Phænomenon* afforded his Speculation. But I have endeavour'd to bring it home to my own Profession, to justify a Notion of some Importance, tho' much disputed, concerning an alteration made by the Air upon Humane Blood, both as to Colour,

lour, and other Vertues. You have also this difference in the manner of exhibiting, in Mr. Boyle's Experiment you have the Filings of Copper contiguous with your *Menstruum*, in ours you have a clear Colourless Liquor, and no Materials at all in your Glass to give the least Umbrage to this sudden change of Colour ; but this cannot be performed without some *Encheirests* and an *Apparatus* extraordinary.

' In making the Experiment you will observe, for
' four, five, or six days the Tincture will be growing
' deeper and deeper, and then will keep a stand for two
' or three days more or less, and afterwards will gradual-
' ly decline until it become quite pale, and void of all
' Colour. When it is in this state, the easiest way of
' performing the Experiment for your own satisfaction,
' is to decant this clear Spirit into a Glass so as to leave
' all the Filings behind, and that will demonstrate that
' the Filings did not give this Tincture *de novo*, but that
' it belongs to the influence of the Air. But in case you
' are furnish'd with an Air-pump, and can pour off this
' palid Liquor in a *Vacuo Aeris*, and there stop it up se-
' curely, you may then preserve it so long as you please,
' and exhibit it to advantage, which is the way I com-
' monly use. You may also observe, that so soon as
' you let in the Air, the upper Superficies immediately
' tinges first, and so descends deeper and deeper until it
' has penetrated the whole, and this it does the sooner, if
' the Glass be wide, and the Liquor by consequence have
' a large Superficies: Or if you pour it out of one Glass
' into another, the Air makes a more sudden change of
' the whole.

That Liquors should lose their Tinctures is not to be wonder'd at, for even Ink it self by standing still will lose much of its Tincture, and so do the Tinctures of many Minerals, Tincture of Sulphur, and of Salt of Tartar will lose their Tinctures, and many Vegetables are not
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long to be preserved, but do grow turbid, some pale, and colourless, and leave their *Menstruums*, and precipitate to the bottom, and are not easily if ever recover'd. But in our Experiment we have some things very uncommon, a deeply ting'd Liquor grows pale and colourless in a few days, without any admission of Air or any other Ingredient to disturb it, or to cause any discernable precipitation or separation. Yet when I consider that two Grains of Copper will give a deep Colour to three Ounces of Urinous Spirits, we need not expect any great quantity should be discharg'd out of the Liquor to be very conspicuous at the bottom, which does better solve it than a bare change of Texture can do; namely, to allow it to subside to the bottom of the Glass, tho' it be scarce perceptible by reason of the Filings that may conceal it. But a yet greater difficulty emerges to account for, which is, That since our *Menstruum*, (that is, our Spirit) is divested of its Venereal Particles, which gave the Tincture, and is become as clear as Rock-water, and being separated from its Metalline Filings, does yet upon the approach of the Air immediately afford a very Blue Tincture. This indeed plainly shews, that there must be conceal'd in the Pores of the Liquor, such Particles as are of a Cupreous Nature. But how may this come to pass? To which I answer, I cannot be so vain to think, that the Air gives the matter of the Colour to the Spirit, but that it conveys into it such Particles as do stimulate and give motion to the *Menstruum*, and inable it to dissolve those Particles thoroughly, that for want of more Air had not been fully broken in pieces.

In the next place, I discover two very differing sorts of Matter that our Urinous *Menstruum* acts upon in this Experiment. One I call a Sulphureous Matter, which gives the Blue Colour, and does let it fall again; and another which deserves the name of Saline; but tho' it be taken up into our tinging Spirit, does yet notwithstanding

standing afford no Tincture whilst secluded from the Air : This was made to me very plain and clear, for having found out a way to separate a white slimy substance out of our clear Liquor, I then destroy'd the Experiment, so that when expos'd to the Air the *Menstruum* would no more give the least Tincture : For a farther confirmation, this white Saline Substance being in a small quantity dissolved in any proper Urinary *Menstruum* exhibits the Experiment set down to advantage, and gives a much finer and brighter Colour than what is drawn from Crude Copper, or from the Sulphureous parts : But since the method above is more feasible, I will not spend time for fear of discouraging the Undertaker of an Experiment, to set down this very elaborate method of procuring the Salt of *Venus*.

The great Interest the Air has in this Experiment made me think of applying it to the great change that is made upon Blood ; for it is obvious to every Body that there is a great difference in Colour betwixt the Venal and Arterial Blood, the Venal so soon as it is let out of the Vein is observed to be of a dark Complexion, and requires some time to be expos'd to the Air before it obtains a florid Red, and that only Superficies which is contiguous to the Air, does for a good while become Red ; for I have turn'd up a Cake of Blood twenty four hours after it had been let out, and found it of a very dark and opaque Colour, but the Air has immediately given it a bright and florid Red Tincture. This so manifest a change made by vertue of the Air is obvious even *Lippis & Tonsoribus*, which would make one wonder to find great Philosophers and Anatomists endeavour to assign more foreign and ambiguous Causes of so demonstrable an effect of the Air. Thus our Famous Anatomists Dr. *Higmore*, and Dr. *Needham*, and others, have adventur'd to do ; who would have respiration to be chiefly to promote the Circulation of the Blood, and that

great *Apparatus* of Air-Vessels to be for a Fan to cool the Mass of Blood, and that the Air returns unalter'd, and not capable of making any great alteration, being denied any ingress into or mixture with the Blood. The Observation is certain and unerring, that the Venal Blood as it passes the Right Ventricle at its entrance into the Lungs is of a very opaque and blackish Complexion, and in its passage through the Lungs before it comes to the Left Auricle, is changed into a very florid and bright Red. I have often observed that Persons that have Vomited Blood upon a Rupture of some Capillary Vessels of the Lungs, have sent up a very frothy or spumous Blood, and at the same time of a bright Scarlet Red: That it was frothy, argues that the Air had incorporated with it; that it was Red was due to the tingeing power of the Air. To expect that this change should be made in the Heart by any Local Ferment, or *flamma vitalis* is fruitless; because we find it performed before its arrival there; the structure of the Heart denoting that Engine to be principally made for projecting the Blood in order to a Circulation through those various Arteries or Pipes which are branched from the Heart. Let us therefore examine the structure of the Lungs, and very briefly consider them, we shall soon discover it to be a Pneumatic Engine made principally for taking in Air, and that in great quantities, which a Remark in the Fourth Corollary does much favour. It's true, we may call the Lungs a Contexture of Veins, Arteries, Nerves, Lymphæducts, &c. and that these do very much make up the Parenchyma (as some do use the word) of the Lungs; but yet we shall find the great bulk of the Lungs to be Vesicular: It seems to me to be a Continuation of the *Aspera Arteria*, or Wind-pipe, divided and subdivided into many Branches, and these still spun out into lesser and lesser Pipes, all of them hollow; the farther they run the thinner their sides do grow, which
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upon the Inspiration of Air do swell up and grow round, and upon expiration do fall something flaccid, and abate something of that Figure, as the Microscope does plainly represent. That these Pipes should run to a great length hollow, tho' very small, I the less wonder at, having seen a hollow Pipe of Glass drawn out at the flame of a Lamp so very small as to be scarce visible without a Microscope, and yet was so hollow as to take up tinged Spirit of Wine, where only the ordinary pressure of the Ambient Air impell'd it. Nor will compress'd Air be kept out where there is the least Pore left open, which makes it more than probable ~~that~~ it should insinuate into this Machine, so truly adapted to receive the Air, and that in great quantity, the *Apparatus* of Air-Vessels being so very considerable, which appears in each inspiration; for the Luugs are stretch'd at that rate as to take up double the room they do in the state of expiration, or in their compress'd state; and even in this state the Air-bladders are not fully evacuated, but contain Air for good purposes. Nor can it be pretended that any augmentation is due to the Expansion of the Blood-Vessels, or any other which do not swell beyond their usual Tension in each inspiration. The Sanguiferous Vessels are divaricated through all the Lobes of the Lungs, and do give a very close attendance to each *Vesicula* (for there is not the least *Vesicula* but has a Capillary Vessel which intimately insinuates into it) in order to receive some considerable benefit from it; and this appears to the Eye, for in an instant a dark and foul Blood is changed into a bright florid Red Colour, which would make a Man of Contemplation to admire it, and a Lover of Red Wine, who is presently offended to see his Liquor foul, (and perhaps justly condemns it for unwholesome) wish for such another expedient to clear up his turbid Liquor. Thus the very structure of the Lungs, the effect of change of Colour both in the Blood and in our

Experiment, the one from a dark opaque Colour to a noble Scarlet Dye ; the other from a pale or colourless Liquor to a rich *Ultra Marine* Blue, do all combine to do justice to the Air for this celebrated alteration. Nor is the Air thus infus'd into the Lungs for a bare Colour, and of no farther consideration: But I am apt to believe the great Fermentations of the Blood the cause of the Motions and Actions of the Muscles ; the Animal Spirits themselves, the great Spring of Motions, derive their Energy and Powers, if not Nature, from hence.

COROLLARY I.

The Air is full of Volatile Salts none will deny, but that these Salts must bear the name of Nitrous Salts, it has been scarce call'd in question, which this Experiment and some others I have made, do. Nitrous Salts seem to me not to have any property of Volatile Salt : Nitre is a Salt of so fixed a nature, that it will continue melted in a very strong Fire with scarce any Evaporation ; but if you put into it Charcoal, or Brimstone, or give it an Accension by another Eucheiresis you may obtain a great quantity of as fixed a Salt as any Concrete whatever affords ; so that to me Gold seems not of a more fix'd Nature.

COROLLARY II.

A standard of Volatile Salts should be settled, at present I can think of none better than Water. That Salt which in Distillation is more fix'd than Water, ought not to be reckon'd amongst Volatile Salts : This standard will be justified by good measures, grounded on Experience ; for all Salts that are truly Volatile, as far as I could observe, are really lighter than Water, that is in a Chymical sense, do with a less degree of Fire sublime
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in our Glasses, or come over the Helm, than Water does. This I find justified in our Volatile Salt of Amber erroneously so call'd, for it does not come up to our standard of Volatility, and is really no Volatile Salt, as will be made appear : If you take this supposed Volatile Salt and Distil it in a Retort, or Head, and Body, with common Water, the Water will ascend in such a degree of Fire where the Salt will not, for you must increase your Fire considerably to make it rise after the Water is gone, and has left the dry Salt at the bottom. This made me enquire farther into the properties of this Salt, which did not at all Correspond with Volatile Salts (for all true Volatile Salts are Alkalies) but on the contrary would ferment with them, and quite destroy the property of true Volatile Salts, by bringing them to a dull insipid Salt, which some call *Sal Neutrum* ; and also by fixing their Volatile Nature, not only in putting them by the standard of Volatility, but also does quite destroy their spiritous and stimulating smell, by vertue of which they have been always deservedly esteem'd such excellent Cephalick Medicines. Therefore examining this Salt yet a little farther, you will plainly prove it to be an Acid, that Corrodes Iron, turns Syrup of July-flowers Green, destroys the Tincture of *Lignum Nephriticum*, and does not ferment with common Acids ; so that it plainly belongs to the Tribe of Acids, and should be struck out of the Catalogue of Volatile Salts ; and perhaps out of the number of Specific Cephalicks, and rather be degraded amongst the Diureticks, and even in that rank to have but an inferior station ; for it seems to me to be but a dull Medicine, and more Valuable for its Price than great Vertue, especially if quite divested of all its Oyl, in which the great *Cephalic* and *Cordial* Vertue must needs be own'd to consist.

C O R O L L A R Y III.

That Volatile Salts have a great property to draw Tinctures, and do particularly advance those Colours that are dispos'd to be Red : For tho' Spirit of Wine be a very Catholic *Menstruum*, and draws a very deep Tincture of Cochine, yet we have often observed that if we put to this Tincture, when highest, a small proportion of Volatile Salt that would advance it to a great, even a double degree. Thus I have observed it to advance the Tincture of Arterial Blood ; and which is very Curious, if you dissolve it in your Blood whilst you are Bleeding at one of your Veins, that Blood will become very florid, and like Arterial Blood. Therefore since Nitrous Salts produce none of these tingeing Effects ; this Corollary seems much to favour the Notion, That the Effects of the Air upon the Blood, may be due to such Salts as are of a Volatile Alkalifat Nature.

C O R O L L A R Y IV.

Contagious Diseases are Communicated by the Air inspired at the Lungs ; and this seems more probable than what Dr. *Needham* and others, have endeavour'd to make out with more difficulty ; in attributing the same effect to the Air taken in our Meat by Mastication, and swallow'd down in our Drink, and communicated to our Chyle from thence to our Blood and Spirits ; but this way a very small quantity of infected Air is Communicated, if we compare it with what is Communicated to the Lungs : For in each inspiration, Humane Lungs of an ordinary size do at least take in such a quantity of Air as will fill up a Quart Bottle, and in the space of a Minute I have made Twelve Respirations, (when I was very sedate, and drew in my Breath very treatably) and
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in that time by consequence took in as much Air as would fill up a Vessel capacious enough to hold three Gallons of Water ; and it's plain that the Air expired returns much alter'd, for as much as the Breath or *Halitus* returns impregnated with a moist Vapour, and such a one as does many times indicate the Temper of the Blood: From this *Halitus* Imposthumations of the Lungs are frequently predicted: Such as have Sulphureous Blood shall emit no very pleasing but rancid Exhalations: Nor does the Blood only clear it self of some Vapours in expiration, but also imbibe, and impregnate it self with such Particles as are necessary to maintain Life in inspiration; for a Man could not subsist long in a Tun of Air, should he be kept close in so capacious a Vessel, as we have found by Experiments made with several respiring Animals, Dogs, Cats, and Birds, &c. that these would soon die there; so that we need constant supplies of vast quantities of fresh Air, which makes me believe that those Particles separated out of the Air by the Lungs are very sparingly deliver'd or mix'd with the common Air, but yet with this difference, that the more compress'd the Air is, the more it contains of that vivifying Salt or Spirit, and the contrary, the more rarified the less is found; for we are told by the Experience of such as have been on the Pike of *Teneriff*, that their breathing is more difficult there than at the bottom, where the Air is more compress'd. And we have found Birds and Mice, &c. would live as long again, in a Vessel where we had crouded in, by a Syringe (or any other condensing Engine) a double quantity of Air, as they did where they were confined only to common Air. To conclude, since the vivifying Particles in the Air seem to be very sparingly disseminated through it, I am apt to believe that the Noxious and Pestilential are more sparingly scattered up and down; (the Author of Humane Nature having taken more

more care for its Preservation than for its Destruction) and therefore it may much better be inferr'd from the Premises, That Contagious Diseases must needs be communicated to the Blood by Inspiration into the Lungs, rather than any other way.

II. *An Extract of a Letter from Dr. William Oliver, Communicated by Walter Moyle, Esq;*

Torbay, the 15th. of July, 1693.

S I R,

WHen we Cruised in the Bay of *Biscay*, *June* the 8th, and had a hundred Fathom of Water, we took a Quart Glas Bottle stoppt with a large Cork, and after tyed down with a strong Packthread, as we use to for Bottle Syder, or Ale, fastening our Bottle to our Plumbing-rope, and with a Lead at the end, sunk it to the bottom of the Sea, which as soon as we perceiv'd, we drew it up again, and found the Cork quite press'd thro' the neck of the Bottle into its cavity, and the Bottle full of Salt Sea-Water. We repeated our Experiment with another Bottle and Cork in the same manner as before, but the Cork being not found, the Sea-Water soak'd thro' it, and the Bottle was half full of Water, so the Cork remain'd in the mouth of the Bottle not press'd down at all. We repeated our Experiment a third time in ninety Fathom of Water, with a very sound Cork, and much larger than the mouth of the Bottle, for we were forc'd to beat it in with a Hammer as far as it would go, leaving about an inch of the Cork above the mouth of the Bottle, and tyed down as before, but it succeeded not so well as at first, tho' the Cork was now press'd down into the neck, and became level with the mouth

Fig: 1



Fig: 2

